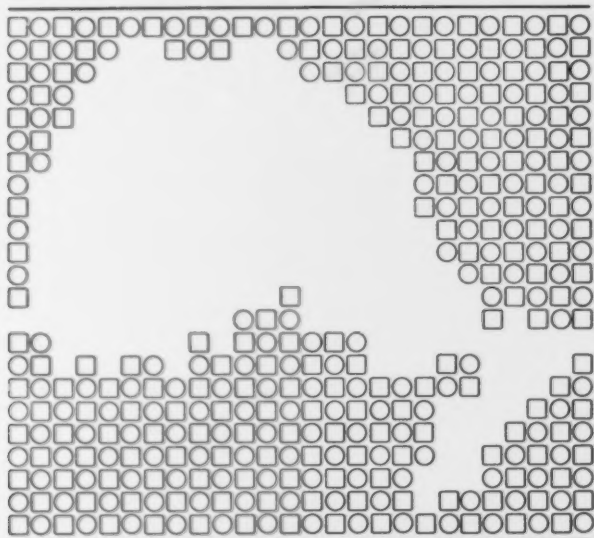




Ontario
Ministry of
Labour

Occupational
Health and Safety
Division

Designated Substances in the Workplace: A Guide to the Mercury Regulation



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**Designated Substances in the Workplace:
A Guide to the Mercury Regulation**

March 1986

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Introduction

This guide has been prepared to help employers, workers, members of joint health and safety committees, supervisors and occupational health personnel meet the requirements of the designated substance regulation respecting mercury in the workplace and to understand the responsibilities this regulation places on all participants in the workplace health and safety system.

The advice in this guide is the interpretation, by officials of the Occupational Health and Safety Division, of the Occupational Health and Safety Act (the Act) and regulations.

The advice does not have binding effect but is intended to provide general answers to possible questions asked in the context of a specific situation. It is being used by staff of the ministry to assist in the administration of the mercury regulation.

Questions of construction and application will find their ultimate answer given by the courts where a contest ensues as to construction or application of a legislative provision.

The Occupational Health and Safety Division of the Ministry of Labour is responsible for administering the Act. The Regulation respecting Mercury, Ontario Regulation 141/82 was filed with the Registrar of Regulations on March 9, 1982. The provisions relating to the assessment came into force on the date of filing; those relating to control measures came into force on June 7, 1982.

This guide is intended as a supplement to the booklet entitled **Designated Substances in the Workplace: A General Guide to the Regulations** to help employers meet the requirements of the mercury regulation. It reviews the health effects of mercury, its uses and the forms of workplace exposure. In addition, it provides information on the application of the regulation, allowable exposure levels, the assessment and control program and medical surveillance.

It is important that both this guide and the general guide to the regulations referred to above be consulted.

For further information on any aspect of the mercury regulation, you should contact the Inspectorate of the Ministry of Labour at the appropriate district office. Appendix 3 lists the addresses and telephone numbers of the district offices of the ministry.

1. The Hazards of Mercury in the Workplace

What Is Mercury and How Is It Used?

Mercury is a silver-coloured metal that is liquid at room temperature, a characteristic that makes it unique among metals and led medieval alchemists to believe it had magical properties. Mercury is heavy and is a good conductor of electricity. Its chemical symbol is Hg. Mercury may be used industrially in its pure metallic form or combined chemically with other elements as mercury compounds.

Elemental or metallic mercury, the pure metal, is sometimes amalgamated (alloyed) with other metals such as gold, silver, copper and tin for use in the manufacture of a variety of products.

The greatest use of elemental mercury in Ontario today is in electrical equipment, such as alkaline batteries, fluorescent light bulbs and "silent switches". It is also used in medical and scientific instruments such as thermometers, manometers and barometers. Until the mid-1970s, mercury was widely used in chlor-alkali plants for the manufacture of chlorine gas and caustic soda. However, most chlor-alkali plants in Ontario have now converted to a method that does not use mercury. Elemental mercury has also been used in gold and silver extraction, jewelry making and for coating the backs of mirrors. It is still widely used in dental amalgams.

Organic mercury compounds contain a mercury atom covalently bonded to carbon in an organic molecule. The alkyl mercury compounds, such as methyl mercury, are a class of especially toxic organic mercury compounds. Alkyl mercury compounds are used

minimally in Ontario today, primarily in research institutions. Organic mercury compounds were once used in agriculture as fungicides, seed dressings and root dips, but these uses were banned by the government of Canada in 1970. Organic mercury compounds may be used as agents to control slime in paper mills.

Inorganic mercury compounds (or mercury salts) are substances in which mercury is combined with an element other than carbon. Two different types of mercury ions (mercury atoms with a positive electrical charge) may be found in mercury salts. Compounds containing the mercuric ion (Hg^{++}) are usually more corrosive and therefore more acutely toxic than those containing the mercurous ion (Hg^{+}). Examples of inorganic mercury compounds are mercuric nitrate and mercurous chloride.

Inorganic mercury compounds are used as preservatives and stabilizers in some latex paints, oil-based exterior paints and caulking compounds. They are used in leather tanning compounds, photographic chemicals, pesticides, explosives, and as catalysts in chemical manufacture, although these uses are declining. Inorganic mercury compounds have also been used in several drugs and medicines, antiseptics, skin ointments and diuretics.

What Forms of Mercury Can Be Dangerous to Workers?

Mercury can affect the health of workers if it is in a form that may be inhaled, ingested or absorbed through the skin.

1. **Mercury vapour:** "Vapour" refers to the gaseous form of a material that has been given off (evaporated) from a liquid. The "volatility" of a liquid refers to how rapidly it will vaporize. The higher the temperature of the liquid, the more vapour it will release in a given time. Elemental mercury is dangerous because it can release enough vapour at room temperature to reach harmful levels in unventilated areas. Even small quantities of elemental mercury can produce

dangerous levels of mercury vapour because mercury tends to break up into small droplets, which increases the exposed surface area, causing more rapid vaporization. Vapour may also be given off by organic mercury compounds.

2. **Dusts:** Exposure to mercury may occur through the inhalation of dusts of inorganic and organic mercury compounds or dust particles to which mercury vapour has adhered. Dust particles with a diameter less than five micrometres (5/1,000,000 metre) are particularly hazardous as they can be inhaled deeply into the lungs.
3. **Liquids:** Liquid forms of mercury include elemental mercury itself and solutions of organic and inorganic mercury compounds. These liquids can be hazardous if they are ingested or come into direct contact with the skin or eyes.

How Is Mercury Absorbed Into the Body?

Mercury may enter the body through inhalation, skin absorption or ingestion:

1. Inhalation:

Most occupational exposure to mercury occurs through breathing in airborne vapours and dusts. Workers may not be aware of the presence of mercury vapour in the workplace because it is odourless and colourless. About 80 per cent of inhaled mercury vapour can pass from the lungs into the blood stream and be carried to other parts of the body.

It is not known conclusively to what extent inorganic mercury compounds from inhaled dusts are absorbed into the body through the lungs.

2. Absorption through the skin:

Most forms of mercury can be absorbed into the body through direct contact with the skin, but it is not known to what extent absorption occurs. It is suspected that organic mercurials, especially the alkyl mercury compounds, are absorbed to a greater extent than are elemental mercury and inorganic mercury compounds.

3. Ingestion:

Ingestion of mercury may occur when workers consume food and drink, chew gum or smoke cigarettes that have been brought into the work area and have become contaminated with mercury. It also results from eating or smoking with contaminated hands. In addition, Mercury may be ingested when inhaled mercury particles are cleared from the lungs by the lungs' protective mechanism. Cilia (hair-like projections of cells) that line the respiratory tract move these particles from the lungs to the throat where they are swallowed.

The degree to which ingested mercury is absorbed into the body through the gastro-intestinal tract depends on a number of factors, including diet and the solubility of the ingested substance. Elemental mercury and inorganic mercurous compounds have low solubility and the extent of absorption is fairly low. About 10 to 30 per cent of ingested mercuric compounds may be absorbed. Because of their corrosive properties, mercuric compounds can be extremely hazardous - even fatal - if ingested in large quantities. Organic mercury compounds are much more readily absorbed than inorganic compounds.

Why Is Mercury a Health Hazard?

Mercury can cause serious damage to a number of systems in the body. Like many other poisons, mercury can be harmful following a high dose received in a short period of time (acute poisoning) or

after long-term exposure to lower doses (chronic poisoning). The purpose of the control program for mercury is to prevent these harmful effects.

Overexposure to mercury can affect:

The Nervous System: Mercury poisoning can harm the nervous system, resulting in emotional and psychological disturbances, muscle weakness and tremor. Elemental mercury vapour is more harmful to the nervous system than are inorganic mercury compounds. The alkyl mercury compounds are especially damaging.

The Kidneys: Mercury accumulates in the kidneys and can damage kidney function. Chronic mercury poisoning can lead to proteinuria (protein in the urine).

The Mouth: Mercury poisoning can lead to inflammation of the gums, loose teeth, and excessive salivation.

The Skin: Direct contact with elemental mercury and some mercury compounds can cause dermatitis and skin irritation. Some mercuric compounds, such as mercuric chloride, are very corrosive and can cause chemical burns.

The Eye: Elemental mercury and soluble mercury salts such as mercuric chloride can cause severe eye injuries if splashed into the eye. Chronic exposure to mercury vapour can discolour the surface of the lens of the eye. Acute exposure to alkyl mercury compounds can cause loss of peripheral vision.

The Respiratory System: Inhalation of high concentrations of mercury vapour can severely damage the respiratory tract, resulting in cough, chest pains, shortness of breath and — in extreme cases — bronchitis or pneumonia. Inhalation of alkyl mercury compounds is also irritating to the membranes of the nose, mouth and throat.

The Gastro-intestinal System: Vomiting and abdominal pain may result from inhalation or ingestion of large amounts of inorganic or organic mercury compounds. The ingestion of inorganic mercuric compounds is especially dangerous; these can cause corrosion of tissues, resulting in severe gastro-intestinal damage that may prove fatal.

The Reproductive System: Exposure to alkyl mercury compounds during pregnancy can cause cerebral palsy in the fetus. While it is not known whether other forms of mercury can have similar effects, the Code for Medical Surveillance for Mercury advises that exposure of women capable of bearing children be kept to a minimum.

Symptoms of **acute mercury vapour poisoning** include tremor of the limbs, inflammation of the mouth, excessive salivation, metallic taste, abdominal pain and vomiting. Severe kidney inflammation may occur within one to two weeks following acute exposure to soluble inorganic salts of mercury. Inhalation of high concentrations of mercury vapour may result in cough, chest pains, shortness of breath and bronchitis or pneumonia.

Early signs of **chronic mercury poisoning** may not be recognized because they resemble many common ailments. Symptoms include weakness, fatigue, loss of appetite, insomnia and minor psychological changes. More severe chronic poisoning lead to pronounced symptoms of nervous system damage, including tremor and erethism — an abnormal state of emotional instability. Other symptoms of chronic poisoning are proteinurea, inflammation of the mouth and excessive salivation.

The major health effects and routes of exposure of the different types of mercury and mercury compounds are summarized in Table 1 on the following page.

TABLE 1

**MAJOR HEALTH EFFECTS AND ROUTES OF EXPOSURE OF
MERCURY AND MERCURY COMPOUNDS**

<u>Form</u>	<u>Major Exposure Route</u>	<u>Major Health Effects</u>
Elemental Mercury	Inhalation of vapour	Nervous system disturbances - muscle weakness, tremor, emotional instability; lung damage if high concentrations inhaled
Inorganic Mercuric Compounds	Inhalation of dust, ingestion, skin contact	Chemical burns, kidney damage, severe gastrointes- tinal damage if ingested
Mercurous Compounds	Inhalation of dust	Kidney damage
Organic Mercury Compounds	Inhalation of dust, vapour	Nervous system damage; cerebral palsy in fetus if exposure occurs during pregnancy

Chemical Reaction and Explosion Hazards of Mercury

By itself, elemental mercury is not explosive. However, explosions may occur or explosive compounds may be formed when mercury is brought into contact with a number of chemicals, including:

acetylene	ethanol and nitric acid
ammonia	methyl azide
boron phosphodiiodide	oxalic acid
bromine	sodium carbide
chlorine	
chlorine dioxide	

In addition, several mercury compounds present fire or explosion hazards. Fulminate of mercury, for example, is a very explosive compound used in the manufacture of percussion caps. Other explosive mercury compounds include:

mercuric azide	mercurous azide
mercuric nitride	mercurous fluoracetylde
mercuric chlorite	mercurous hypophosphate
mercuric cyanide oxide	

Mercury salts may form hazardous chemical reactions with acetylene, butynediol and acid, and nitromethane. Other hazardous reactions may occur between mercury compounds and other substances. A Material Safety Data Sheet (MSDS) or a handbook of chemical reactions should be consulted regarding any mercury compound used in the workplace.

2. The Mercury Regulation

Who Is Covered by the Mercury Regulation?

With two major exceptions, the regulation applies to every employer and worker at a workplace where mercury is present and at which a worker is likely to inhale, ingest or absorb mercury.

The exceptions, to whom the mercury regulation does not apply, are:

- dentists and workers in dental offices; and
- constructors, employers carrying out construction projects and workers working at construction projects.

Must the Employer Protect Workers Who Are Present in the Workplace But Who Are Not Working Directly for the Employer?

An employer to whom the regulation applies must take every reasonable precaution to protect a worker present in the workplace, even if that worker is not directly employed by the employer. Such a worker must comply with the requirements of the employer. These obligations are not applicable to constructors, employers carrying out construction projects or workers on construction projects.

What Are the Allowable Airborne Concentrations of Mercury?

The exposure of a worker to mercury must not exceed the limits specified in the regulation:

Time-Weighted Average Exposure Concentration

The time-weighted average exposure of a worker to **all mercury except alkyl mercury compounds** must not be greater than **0.05 milligrams per cubic metre (mg/m^3)** of air.

The time-weighted average exposure of a worker to **alkyl mercury compounds** must not be greater than **0.01 mg/m^3** of air.

The time-weighted average exposure of a worker is calculated on the basis of cumulative weekly exposure (40 hours), as indicated in the Schedule appended to the regulation.

Maximum Exposure Concentration

The maximum exposure of a worker to **all mercury except alkyl mercury compounds** must not be greater than **0.15 mg/m^3** of air at any time.

The maximum exposure to **alkyl mercury compounds** must not be greater than **0.03 mg/m^3** of air at any time.

The exposure of a worker to the maximum concentration of airborne mercury must:

- not last longer than 15 minutes at any one time;
- not occur more than four times in a work day; and
- not occur until at least 60 minutes after the last previous exposure to such concentration.

Employers and workers are required to comply with these exposure concentrations by means of engineering controls, work practices, and hygiene practices and facilities. The use of respirators to achieve these limits is restricted to certain conditions, as described on pages 8 to 9 of **A General Guide to the Regulations.**

3. Assessing and Controlling Exposure to Mercury

The Assessment

Chapter 2 of A General Guide to the Regulations describes how to assess the extent to which workers are exposed to mercury. When carrying out this assessment, note all processes involving mercury and the forms in which mercury is likely to be released into the workplace. Pay particular attention to the possibility of spills and leaks of mercury as these can be major sources of contamination. If mercury is present in sealed equipment, assess the possibility that the equipment may break or leak. Note whether maintenance or cleaning of mercury-containing instruments involves exposure to mercury.

One way of assessing the amount of elemental mercury lost to spills is to conduct an inventory of the amount of mercury coming into your workplace and the amount accounted for in finished products. The difference between the two is likely to represent spills, which, if not cleaned up thoroughly and immediately, can lead to a steady release of mercury vapour into the air. Look for visible droplets of mercury around equipment, on floors, on surfaces and clothing. Note the type of floor covering and its potential for retaining spilled mercury. Note particularly any cracks or crevices in which mercury can be trapped. Record the procedure established for cleaning up mercury spills. If it appears likely that mercury has previously been spilled in the workplace, the assessment should include air monitoring as spilled elemental mercury will continue to release vapours.

The rate at which mercury vaporizes increases markedly with an increase in temperature. In your assessment, note the air temperature in any area of the workplace where mercury may be found or where breaks, leaks or spills may occur.

The conclusion of the assessment should comment on whether there is a possibility of a mercury spill and the effect such a spill would have on the health of workers.

Table 2 on page 16 presents a list of occupations that may involve exposure to mercury. Workplaces where these types of work are performed should be carefully assessed for potential for mercury exposure.

It may be necessary, in some cases, to include air sampling as part of the assessment for mercury. The mercury regulation references a Measurement Code for both total mercury and alkyl mercury that specifies methods and procedures to be used for air sampling and analysis required to determine compliance with the exposure limits prescribed by the regulation and to meet the requirements of the mercury control program if one is required. Chapter 6 of A General Guide to the Regulations explains in detail the procedures for air monitoring that may assist in determining the concentration of mercury in workplace air.

The Control Program

Engineering Controls

If a mercury control program is required, it must include engineering controls to reduce the exposure of workers to mercury. These controls may be grouped into the categories outlined in Chapter 4 of A General Guide to the Regulations.

Product Substitution

It may be possible to eliminate mercury from the workplace by replacing it with a less toxic material. For example, substitutes may be available for mercurial compounds used in pesticides, fur and leather treatment, bulb dipping and other processes.

Scientific and medical instruments that contain mercury¹ may be replaced by instruments that use alcohol or that operate electronically. If mercury-containing instruments are used, floor or wall models rather than table-top models should be chosen, if possible, to reduce the likelihood of breakage.

Process Changes

Changes in a process can sometimes help to reduce mercury exposure. For example, temperatures should be kept as low as possible to minimize the vaporization of elemental mercury. Automated and remote control systems can prevent worker exposure. Where appropriate, processes should be designed to minimize the generation of waste mercury by, for example, recycling excess reactants containing mercury. Alarm signals can be installed to warn of equipment or ventilation failure.

TABLE 2**SOME OCCUPATIONS THAT MAY INVOLVE
EXPOSURE TO MERCURY****Metallic Mercury**

amalgam makers	gold and silver extractors
battery makers	health care workers
caustic soda makers	jewellers
chlorine makers	laboratory workers
dental office workers	mercury refiners and purifiers
electrical apparatus makers	scientific instrument makers
electroplaters	and users
makers of fluorescent, neon, and mercury vapour arc lamps	switch makers

Mercury Compounds

ceramic workers	paper makers
dye makers	pesticide makers and users
explosives and fireworks makers	photograph processors
fingerprint detectors	tannery workers
fur processors	textile printers
glacial acetic acid producers	urethane foam producers
ink makers	vinyl chloride producers
laboratory workers	wood preservative workers
paint makers	

Enclosure/Isolation

Any equipment or process in which mercury is used should be designed to make sure that the mercury does not escape into the atmosphere through leaks, breakages or spills. General principles of enclosure and isolation should be followed, as described in **A General Guide to the Regulations**. Equipment used in manufacturing processes should be well-sealed and serviced regularly. Wherever mercury is enclosed in glass, strict precautions must be taken to prevent breakage.

Where possible, areas of the workplace where mercury is used should be segregated from other areas and restricted to workers directly involved in mercury operations. Such operations should be enclosed in the smallest convenient space and be adequately ventilated.

Where possible, processes involving the handling of mercury should be conducted in ventilated glove boxes or fumehoods. This is especially important if the process involves heating mercury.

Mercury should be stored in air-tight containers to prevent vapours from being emitted into the air. If this is not possible, covering the mercury with a layer of water or oil is a temporary measure to slow the rate of vaporization. While oil is more effective than water in reducing vaporization, a layer of water topped by a film of oil is even more effective. Containers of mercury should be stored in ventilated fume cupboards.

Processes such as filling mercury-in-steel thermometers may involve keeping mercury under high pressures. The slightest leak in such a system can result in a fine spray of mercury being emitted into the work room air. Such a process must be thoroughly enclosed, and regular maintenance must be performed to prevent leaks.

Ventilation

Local exhaust ventilation is necessary for all processes that may result in emissions of mercury. Hoods should be placed as close to the source of emissions as possible to draw vapours away from the worker. It is preferable that dedicated local exhaust systems be used for processes that emit mercury. Dedicated systems are those that are not hooked up to other parts of the plant ventilation system. Good general ventilation with sufficient make-up air is also important wherever mercury is used. The principles of ventilation described in Chapter 4 of **A General Guide to the Regulations** should be observed. Standard practices in the design of industrial exhaust systems can be found in reference texts such as **Industrial Ventilation, A Manual of Recommended Practice**, published by the American Conference of Governmental Industrial Hygienists.

Exhaust air from processes that emit mercury should not be recirculated into the workplace. Contaminated air that is vented to the outside environment must meet the limits on mercury emissions set under the **Environmental Protection Act**. In most cases, this will mean that the ventilation system must be equipped with air filters. Regular maintenance and cleaning of air filters are essential to keep the ventilation system operating properly. Precautions should be taken to prevent exposure when cleaning mercury from air filters.

Workplace Design

The construction of surfaces, floors, fixtures and equipment is very important in facilitating clean-up and recovery of mercury. The following features will help to promote thorough recovery of metallic mercury that has spilled, dripped or leaked.

1. Surfaces should be smooth and free from joints, cracks and recesses. They should be made of materials that are impervious to mercury and that do not amalgamate with

mercury. Woodwork and porous brick should be avoided as they can trap and absorb mercury.

2. Do not use floor carpeting or tiles in areas where mercury is handled.
3. Floor covering should extend about six inches up the walls to eliminate the crack between floor and wall in which spilled mercury can be trapped.
4. Surfaces and floors should be of a colour that makes it easy to detect droplets of spilled mercury.
5. If spills or drips are frequent, floors should be sloped toward a drain that will trap mercury in water or oil.
6. Work surfaces where mercury is handled should be sloped away from the worker. A trough containing water should be attached to the work bench on the side away from the worker to catch spilled mercury.
7. Floor heating, which promotes vaporization of spilled mercury, should be avoided.

Clean-up of Spills

Stringent measures to clean up spilled mercury are an essential part of any control program. Clean-up procedures should be written, thoroughly explained to all staff working with mercury and posted in the workplace.

If it is not thoroughly cleaned up, metallic mercury may remain on floors and surfaces or become trapped in crevices where it may continue to release vapour into the air for a long time. When liquid mercury spills, it tends to divide into small globules. The greater the number of these globules, the more vapour will be released into

the air. Therefore, it is important not to use clean-up methods that would tend to break the mercury into smaller droplets. Small spills of mercury (e.g. a broken thermometer) should be cleaned up immediately with a vacuum cleaner equipped with a charcoal filter or water trap, or a hand held pipette used with a rubber bulb or water pump. Surfaces should then be washed with a mercury-neutralizing solution such as 20 per cent calcium sulphide or 20 per cent sodium thiosulphate. If the mercury has broken up into globules, sulphur powder can be sprinkled over the area immediately after a spill occurs to prevent the mercury from vaporizing before the clean-up is complete. Appropriate protective clothing must be worn when cleaning spills.

A major spill of elemental mercury is an emergency situation. If there is a possibility that such a spill can occur, the control program should designate a person responsible for supervising emergency procedures and clean-up. This person must be able to make immediate decisions regarding appropriate precautions to take when a spill occurs. In order to do this, he or she will have to be familiar with:

- the hazards of mercury;
- the ventilation system in the workplace;
- procedures for monitoring levels of airborne mercury;
- appropriate personal protective equipment in relation to levels of contamination; and
- other workplace conditions that will affect the danger posed by a spill (e.g. volume of the work area, the presence of cracks, tiles, or carpets that could trap mercury, temperature, air flow, etc.).

In the event of a major spill of elemental mercury, the person responsible should take the following steps. (The major steps are summarized on the flow sheet for mercury spill clean-up in Appendix 2.)

1. Evacuate all people from the area of the spill.
2. Contain the mercury vapour in the smallest area possible by:
 - closing all doors between the spill area and the rest of the workplace; and
 - shutting off any ventilation equipment that circulates air from the spill area to the rest of the workplace.
3. Post signs warning of the spill and forbidding entry to the spill area by all unauthorized persons.
4. When entering the spill area, wear appropriate respiratory protection and protective clothing. Open all doors and windows in the spill area to the outdoors. Turn on all exhaust fans that vent air directly outdoors. Turn off the heat to reduce vaporization of mercury.
5. Assess the extent of the hazard. This can include:
 - determining the quantity of mercury that has spilled in relation to the volume of the spill area;
 - taking readings of mercury vapour concentrations with a direct reading instrument (see page 26);
 - assessing ventilation in the spill area; and
 - determining the temperature in the spill area and whether there are any warm surfaces that would promote vaporization of mercury.
6. Contact the appropriate inspection branch of the Ministry of Labour. Phone numbers are listed at the back of this guide.

7. On the basis of the assessment of the hazard decide on appropriate safety precautions, personal protective equipment and clean-up procedures.
8. Make sure everyone involved with the clean-up is aware of proper procedures and the hazards of mercury.
9. Equip anyone who must enter the spill area with appropriate respirators and protective clothing. The Code for Respiratory Equipment for Mercury specifies the type of respirator that must be used, depending on the concentration of mercury in the air. If the concentration cannot be determined, respiratory equipment required for "escape" must be worn.
10. Collect all visible spilled mercury with a vacuum device equipped with a charcoal filter or a water trap. Make sure all mercury trapped in cracks and crevices is picked up. Do not sweep, as this can cause the mercury to break into smaller beads.
11. Wash the spill area with a neutralizing solution that will convert the mercury into a form that will not vaporize. This may be done with a solution of 20 per cent calcium sulphide, 20 per cent sodium thiosulphate or another preparation designed for this purpose. Allow 24 hours before removing the neutralizing solution.
12. After the spill has been cleaned up, monitor the air again for mercury concentration. If levels are high, repeat vacuuming and neutralizing procedures.

Disposal

Waste mercury or mercury-contaminated waste must be stored in air-tight containers or covered with water or oil and kept in a cool

environment. It must be disposed of in accordance with the requirements of the Ministry of the Environment. It should never be burned as this would result in the vaporization of the mercury.

Work Practices

It is important to have an established, written work procedure for processes involving the handling of mercury. This will reduce the likelihood of accidental spills and ensure that spills are cleaned up thoroughly if they do occur. Warning signs should be posted in areas where mercury is handled. Equipment should be well-maintained to prevent the escape of mercury vapour or dust. Proper packaging and storage of mercury in non-metallic containers are essential to prevent leaks and spills. Containers should have labels indicating the composition of their contents, health effects of overexposure, and clean-up procedures.

Workers should receive thorough training in safe handling practices and clean-up procedures. Techniques that will help minimize the vaporization of mercury should be emphasized. For example, where mercury is likely to drip from process operations, a pan of water or oil should be placed under the equipment to catch drips. Similarly, all handling of mercury should be done over containers of water. Mercury should be stored in a cool environment and never placed on radiators or other sources of heat. Work areas where mercury is used should be kept at temperatures below 20°C.

Good housekeeping procedures must be observed in areas where mercury may drip or leak. The area should be vacuumed periodically with a vacuum cleaner equipped with a charcoal filter or water trap. Surfaces should be washed with a mercury-neutralizing solution such as 20 per cent calcium sulphide or 20 per cent sodium thiosulphate.

Workers should be acquainted with first aid and emergency procedures for dealing with accidental overexposure to mercury.

First aid measures should be posted in an easily accessible spot in the workplace. This is especially important if corrosive salts of mercury are used. First aid procedures are provided in Appendix 1 of this guide.

Hygiene Practices and Facilities

Good hygiene practices are important to prevent exposure to mercury through ingestion or skin absorption. They will also help to reduce exposure to vapour that can accumulate on hair, clothing and skin.

The hygiene practices described in Chapter 4 of **A General Guide to the Regulations** should be followed where direct handling of mercury occurs. Workers should be provided with a double locker shower facility (with separate "clean" and "dirty" areas) to be used at the conclusion of each shift. Lunch rooms should be located in a convenient place free from mercury contamination. All food, drink, cigarettes and chewing gum should be forbidden in work areas contaminated by mercury. Hands should be washed with mercury-neutralizing soap before eating, drinking or smoking. An indicator soap is available to make sure that all mercury has been removed. Mercury vapour can cling to hair, clothing and make-up, creating an invisible "cloud" of vapour around the worker. For these reasons, heavy make-up should be avoided, hair should be covered and street clothes should not be worn or stored in areas contaminated by mercury. Personal belongings should be kept in a locker. Eyeglasses should be cleaned at the end of each shift with a mercury-neutralizing soap.

Protective Clothing

Mercury can adhere to loosely woven fabrics and shoe soles. Therefore, workers who may come into contact with mercury should change into protective clothing at the beginning of a shift. Such clothing should be non-porous, without cuffs or pockets and should

fit snugly at wrists, ankles and neck. Shoe covers, head caps and gloves impervious to mercury should also be worn. If corrosive mercury salts are used, workers should wear safety goggles or full face respirators.

Work clothes should be placed in impermeable bags or containers labelled "mercury-contaminated clothing". The laundry service must be alerted to the hazards of cleaning clothes contaminated by mercury. Mercury-contaminated clothing should not be brought home by workers.

Respiratory Protection

The type of respirator that should be worn to protect against exposure to mercury depends on the form and concentration of mercury in the air. The **Code for Respiratory Equipment for Mercury**, which is referenced by the regulation, specifies the type of respirator required for different conditions of exposure. Use of respirators should conform to the practices advised in Chapter 5 of **A General Guide to the Regulations**. While it is not required by the regulation, it is recommended that the end-of-life indicator on air purifying respirators be approved by NIOSH (the U.S. National Institute for Occupational Safety and Health) and be mounted in a position where it can be seen by the wearer while the respirator is on.

The Type of Respirator Required

The respiratory equipment provided by an employer and used by a worker shall meet or exceed the following requirements:

- (1) **Mercury:** (elemental mercury, inorganic mercury compounds and organic mercury compounds other than alkyl mercury compounds)

<u>Airborne Concentration</u> (expressed as elemental mercury)	<u>Type of Respirator Required</u>
Less than or equal to 0.5 mg/m^3	Reusable or replaceable air purifying respirator with an end-of-life indicator.
Less than or equal to 5 mg/m^3	Air-line (NIOSH Type C) supplied air respirator operated in pressure demand or other positive pressure or continuous flow mode.
Greater than 5 mg/m^3	Air-line (NIOSH Type C) supplied air respirator or self-contained breathing apparatus with full facepiece operated in pressure demand.
Escape	Self-contained breathing apparatus with full facepiece operated in pressure demand.

- Notes:**
1. Vapours are defined as the gaseous form of a substance that is normally either a liquid or a solid at ordinary temperatures and pressures.
 2. Respirators need not be worn if the levels of mercury in air are less than 0.05 mg/m^3 . However, if the worker wishes to use a respirator below this level, the correct type of respirator must be worn.
 3. Supplied air respirator does not include a powered air purifying respirator.

(2) **Alkyl Mercury Compounds:**

<u>Airborne Concentration</u> (expressed as total mercury)	<u>Type of Respirator Required</u>
Less than or equal to 0.1 mg/m^3	Supplied air respirator with full facepiece, helmet or hood.
Less than or equal to 1.0 mg/m^3	Air-line (NIOSH Type C) supplied air respirator operated in positive pressure or continuous flow mode.
Escape	Self-contained breathing apparatus.

Air Monitoring

Chapter 6 of **A General Guide to the Regulations** provides advice on the principles of conducting air monitoring to determine worker exposure to designated substances. The **Code for Measuring Airborne Mercury**, which is referenced by the regulation, must be followed when conducting sampling and analysis to determine the personal exposure of workers to mercury and to ensure compliance with the exposure limits. This requirement is subject to section 17 of the regulation, which allows deviation from this Code as long as the employer can demonstrate that the alternative methods used are at least as accurate and precise, and provide at least as much protection, as those set out in the Code. Information on equivalency of alternative sampling and analysis methods can be obtained from the Occupational Health Branch Laboratory of the Ministry listed in Appendix 3.

While an employer must meet these requirements for purposes of the regulation, it may also be desirable to use a quicker method of detecting mercury concentration as a routine check that controls are operating effectively. A number of direct-reading mercury detectors, which provide an instantaneous meter reading of mercury

vapour concentration, are available. There are also several colorimetric indicators that use detector tubes or strips of paper that turn colour on contact with mercury. These methods can only be used to detect mercury vapour; they cannot be used for dusts of mercury compounds.

Sampling for mercury levels should be performed frequently whenever mercury is directly handled or where spills, drips, leaks or instrument breakages occur. Air monitoring should always be performed after clean-up of a metallic mercury spill to be sure that decontamination is complete. Mercury levels should be checked again a few days after the spill to be sure that undetected mercury is not continuing to emit vapours into the air.

4. Medical Surveillance for Exposure to Mercury

The mercury regulation requires that the control program provide for a medical surveillance program that must include:

- pre-employment and pre-placement examinations;
- periodic medical examinations;
- clinical tests;
- health education; and
- record keeping.

The medical surveillance program is outlined in detail in the Code for Medical Surveillance for Mercury, and is designed to protect the health of workers through educating all staff to the health hazards associated with mercury exposure.

The objectives of the medical surveillance program are both preventive and remedial. Medical conditions that may be aggravated by exposure to mercury should be detected at the pre-placement and periodic examinations. By providing a regular check on workers exposed to mercury to detect subsequent adverse health effects, the examining physician can alert the employer and the joint health and safety committee to problems from mercury exposure in the workplace that might otherwise go undetected. This should ensure that remedial steps will be taken. Health education for workers on the health effects of mercury and the manner in which exposure can be limited are also preventive functions of the Code.

Section 3 of the Code explains what the physician should look for at the pre-placement and periodic medical examinations. Medical

records kept by the physician should include the information listed in section 6 of the Code.

Clinical Tests

Section 4 of the Code explains the clinical tests used as part of the medical surveillance program to assess the worker's mercury exposure. These tests measure the concentration of mercury in blood and urine. It must be emphasized that clinical tests are not intended to be used as the only indicator that a worker's health has been affected by exposure to mercury. In some cases, workers may experience adverse health effects due to mercury exposure, even though results of clinical tests have not reached the "action level" specified in the Code. The medical surveillance program therefore includes periodic physical examinations so that other symptoms of mercury poisoning can be detected.

Action Levels

The Code for Medical Surveillance specifies action levels for mercury in urine and blood. The urine test is intended to be used to estimate absorption of mercury and its compounds other than alkyl mercury. Blood mercury analysis is the preferred test for alkyl mercury compounds.

1. Urine

The concentration of mercury in urine has been found to vary widely, even among workers with similar exposure and similar symptoms of mercury poisoning. Therefore, excessive reliance should not be placed on urine tests in assessing exposure.

The concentration of mercury in urine is best expressed in terms of the amount of creatinine in the urine sample. Creatinine is a substance excreted in the urine in relatively constant amounts. This makes it a good reference to use when measuring the amounts of

other substances in the urine. Because the volume of urine may vary widely, it is usually considered more reliable to express mercury concentration in relation to creatinine rather than in terms of total volume of urine. However, if it is not practical to measure creatinine, then milligrams per litre (mg/L) mercury in the urine may be used instead. The regulation sets action levels in terms of milligrams mercury per gram creatinine (mg/g). However, the Occupational Health Laboratory of the ministry has begun to report analytical results in terms of micromoles mercury per mole creatinine ($\mu\text{mol/mol}$).

When a urine sample is found to contain a mercury concentration of 0.15–0.20 mg/g (84–110 $\mu\text{mol/mol}$) creatinine, a review of work practices, health status and personal hygiene practices must be made. If a urine sample is found to contain a mercury concentration greater than 0.20 mg/g (110 $\mu\text{mol/mol}$) creatinine, a second test must be performed as soon as possible to confirm this result. If the results are confirmed, the worker must be removed from exposure. A worker who shows any symptoms of mercury poisoning must also be removed from exposure regardless of the urine mercury concentration. Return to work should not be permitted until the urine mercury concentration is less than 0.10 mg/g (55 $\mu\text{mol/mol}$) creatinine.

It is recommended that urine samples be collected at the end of a work week and at the start of a shift.

2. Blood

Blood tests can also be used to assess mercury exposure. However, these indicate very recent absorption and cannot be considered to reflect chronic exposure. The concentration of mercury in blood is often expressed as milligrams per litre (mg/L) or micromoles per litre ($\mu\text{mol/L}$).

When a blood test for a worker exposed to alkyl mercury compounds shows any concentration of mercury, a review of work practices, health status and personal hygiene practices must be made. If a blood test for alkyl mercury exposure shows a mercury concentration greater than 0.1 mg/L (0.5 μ mol/L), a second test must be performed as soon as possible to confirm this result. If the results are confirmed, the worker must be removed from exposure. A worker must also be removed from exposure if he or she shows any signs of mercury poisoning, regardless of the results of the blood test. Return to work should not be permitted until the level of mercury in blood drops to 0.01 mg/L (0.05 μ mol/L) or less.

Frequency of Testing

The frequency of urine or blood testing should depend on the degree of exposure and the worker's previous test results. Usually, tests should be performed at one to three-month intervals. New workers, workers with special health concerns and workers whose blood or urine mercury levels are rising or fluctuating should be tested more frequently.

Chelating Agents

Chelating agents are drugs that have been used to eliminate mercury from the body. One chelating agent that has been used for mercury poisoning is dimercaprol or BAL. Chelating agents should be used only in unusual circumstances such as acute mercury poisoning and should be administered only under the direction of a physician. They should never be used for preventive purposes as they can have serious adverse health effects.

Analysis of Samples

The Code for Medical Surveillance for Mercury explains the method that should be used to collect blood and urine samples. A separate Code for Determination of Mercury in Blood and Urine details the

analytical methods that should be used by the laboratory to analyse these samples. As specified in section 17 of the regulation, the laboratory may use different analytical methods provided that the methods used are at least as accurate and precise as those described in the Code. The employer must pay for analyses of blood and urine samples and make sure that the analytical methods used by the laboratory satisfy the requirements of the regulation.

The Code for Determination of Mercury in Urine explains the method that is to be used to determine the concentration of mercury by volume of urine. For more reliable results, it is desirable that the urine sample also be analysed for creatinine and that the mercury concentration be expressed in terms of creatinine. However, this is not mandatory.

The Examining Physician

The mercury regulation does not stipulate who shall be the examining physician, thus allowing the worker to select the doctor of his or her choice. As a result, the examining physician may be the company doctor, a private consultant with whom the employer contracts services, a physician on the staff of a clinic or the personal physician of the worker. Every examining physician must know the contents of the Code for Medical Surveillance and his or her responsibilities. Where there is more than one examining physician, a physician should be appointed in a co-ordinating role. The role of the co-ordinating physician, who should be selected jointly by the employer and the joint health and safety committee, should be to standardize examination and test procedures, maintain medical records and identify any trends in examination and test results.

Physicians' Reporting Protocol

The regulation requires the examining physician to advise the employer and the worker whether the worker is fit, fit with

limitations or unfit for exposure to mercury. This determination is a professional judgement based on the results of medical examinations and clinical tests. **The physician must give this opinion without disclosing to the employer the results of the examinations or tests.**

The designated substance regulation for mercury requires the physician to advise the committee in writing of the results of clinical tests, along with an opinion as to how these tests should be interpreted and an opinion as to the fitness of the worker for exposure. In all such cases, the committee must receive this information on a confidential basis. If the physician has advised the employer that a worker is fit with limitations or unfit, he or she must also report this information to the Chief Physician of the Occupational Health Medical Service of the Ministry of Labour. These requirements are specified in sections 16(1), 16(3) and 16(5) of the regulation.

5. Appendices



Appendix 1 – First Aid for Overexposure to Mercury or Mercury Compounds

<u>Exposure</u>	<u>First Aid</u>
Eyes	Immediately flush with running water for at least 15 minutes. Contact physician immediately.
Skin	Remove contaminated clothing. Wash with warm water and soap. Contact physician immediately.
Inhalation	Remove victim from vapour. Restore breathing if necessary. Contact physician immediately.
Ingestion	If unconscious, place in recovery position (on side, head turned to side, arms and one knee bent). Vomiting may occur so ensure that breathing is not restricted. If conscious, give 1-2 glasses of milk. Contact physician immediately.

Appendix 2 – Flow Sheet for Inspectors

MERCURY SPILL CLEAN-UP

MERCURY

HAZARDS

Spilled mercury may be absorbed by porous surfaces or fabrics and will penetrate small cracks. Mercury can be brought home on clothing and shoe soles. Mercury forms explosive compounds in the presence of ammonia, acetylene and ethanol/nitric acid. Liquid mercury when mixed with chlorine dioxide will explode violently. Mercury is also incompatible with other substances as listed in the mercury data sheet for inspectors.

Mercury liquid evaporates readily in air. Mercury vapour is odourless, colourless and very toxic.

Vaporization increases significantly with increased temperature. High levels of mercury in air may occur in poorly ventilated areas.

Untrained workers may be seriously injured.

CONTROLS

Use care in handling mercury. Use unbreakable, sealed containers. Handle and store mercury in well ventilated areas with non-porous surfaces. Avoid contact with mercury. Cover mercury with water or preferably oil to slow vaporization. Keep mercury away from chemicals which react violently with it.

Evacuate area of all unnecessary persons.

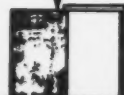
Open windows and doors to outdoors and turn on exhaust fans. Keep doors to other rooms closed.

Instruct and train every worker required to clean up mercury in the hazards of mercury exposure and in the use of respiratory equipment and protective clothing.

Hg Spill

Evacuate Area

EXIT



Instruct & Train
Clean-Up Crew

FLOW SHEET FOR MERCURY SPILL CLEAN-UP (Cont'd)

MERCURY SPILL CLEAN-UP

MERCURY

HAZARDS

High levels of mercury in air may occur in the clean-up area.

Spilled mercury releases vapour. Dry sweeping spreads mercury.

Mercury is difficult to remove from wooden floors, cracks and carpeted areas.

High levels of mercury in air may occur if mercury has been missed during clean-up.

Waste mercury releases vapour.

CONTROLS

Every worker required to be in an area where high levels of mercury may occur shall use a respirator that meets or exceeds requirements set out in the Code for Respiratory Equipment for mercury. Protective clothing shall be provided.

Collect all visible spilled mercury with suction apparatus equipped with charcoal filters to prevent escape of mercury vapour. A water trap may be used to collect mercury for reuse.

Mop spill area with 20% calcium sulphide or 20% sodium thiosulphate solution to neutralize mercury that may have been missed. Allow 24 hours before removing the neutralizing agent.

Monitor the air to determine if decontamination is complete. Treat spill area again if necessary or discard contaminated material.

Recycle waste mercury. Keep containers labelled and closed. Do not incinerate. Keep waste mercury covered with water or preferably oil to slow vaporization.



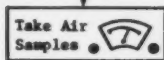
Provide Protective Equipment



Collect Spilled Mercury



Treat Spill Area



Take Air Samples



Waste Hg

Appendix 3 – Ministry of Labour District Offices

Barrie

Industrial Health and Safety
114 Worsley Street
L4M 1M1
(705) 722-6642
1-800-461-4383*

Elliot Lake

Mining Health and Safety
Algo Centre
151 Ontario Avenue
P5A 2T2
(705) 848-2885

Hamilton

119 King Street West
L8N 3Z9
Construction Health and Safety
Industrial Health and Safety
(416) 521-7736
1-800-263-6906(8)*

Kingston

1055 Princess Street
K7L 1H3
Construction Health and Safety
Industrial Health and Safety
(613) 547-3414
1-800-267-0915*
Mining Health and Safety
(613) 547-3418
1-800-267-0915*

Kirkland Lake

Mining Health and Safety
4 Government Road East
P2N 1A2
(705) 567-5241

Kitchener

824 King Street West
N2G 1G1
Construction Health and Safety
Industrial Health and Safety
(519) 744-8101
1-800-265-8723*

London

205 Oxford Street East
N6A 5G6
Construction Health and Safety
Industrial Health and Safety
Mining Health and Safety
(519) 439-3231
1-800-265-4707*

North Bay

Industrial Health and Safety
1500 Fisher Street
Northgate Square
P1B 2H3
(705) 476-2711
1-800-461-1654*

Ottawa

2197 Riverside Drive
K1H 7X3
Construction Health and Safety
Industrial Health and Safety
(613) 523-7530
1-800-267-1916*

Peterborough

139 George Street North
K9J 3G6
Construction Health and Safety
(705) 742-3436
1-800-461-1425*
Industrial Health and Safety
(705) 876-1800
1-800-461-1425*

Richmond Hill

Mining Health and Safety
10720 Yonge Street
L4C 3C9
(416) 884-6551
1-800-268-3829*

St. Catharines

205 King Street
L2R 3J5
Construction Health and Safety
Industrial Health and Safety
(416) 682-7261
1-800-263-7260*

Sarnia

Industrial Health and Safety
700 Christina Street North
N7V 3C2
(519) 336-1200
1-800-265-1416*

Sault Ste. Marie

390 Bay Street
P6A 1X2
Construction Health and Safety
Industrial Health and Safety
(705) 949-3331

Sudbury

199 Larch Street
P3E 5P9
Construction Health and Safety
Industrial Health and Safety
(705) 675-4455
1-800-461-4000*
Mining Health and Safety
(705) 675-4464
1-800-461-4000*

Sudbury

260 Cedar Street
P3B 3X2
Mining Health and Safety
(Chief Engineers)
(705) 675-4468
1-800-461-4000*

Thunder Bay

435 James Street South
P7E 6E3
Construction Health and Safety
Industrial Health and Safety
(807) 475-1691
1-800-465-5016(7)*
Mining Health and Safety
(807) 475-1675
1-800-465-5016(7)*

Timmins

273 Third Avenue
P4N 1E2
Construction Health and Safety
Industrial Health and Safety
Mining Health and Safety
(705) 267-6231
Zenith 57740* (Mining)

Toronto East

2500 Lawrence Avenue East
Scarborough
M1P 2R7
Construction Health and Safety
Industrial Health and Safety
(416) 750-3557
1-800-268-6541*

Toronto West

2 Robert Speck Parkway
Mississauga
L4Z 1H8
Construction Health and Safety
Industrial Health and Safety
(416) 273-7800
1-800-268-2966(7)*

Windsor

500 Ouellette Avenue
N9A 1B3
Construction Health and Safety
Industrial Health and Safety
(519) 256-8278
1-800-265-5140(4)*

**Occupational Health Branch
Laboratory**

101 Resources Road
Weston, Ontario
M9P 3T1
(416) 248-7261

Head Office

400 University Avenue
Toronto, Ontario
M7A 1T7

Construction Health and Safety

(416) 965-7161

1-800-268-8013*

Industrial Health and Safety

(416) 965-4125

1-800-268-8013*

Mining Health and Safety

(416) 965-1328

1-800-268-8013*

Occupational Health

(416) 965-3211

1-800-268-8013*

Special Studies and Services

(416) 965-2493

1-800-268-8013*

Standards and Programs

(416) 965-8710

1-800-268-8013*

*Toll free line. For callers located within the area code but outside the local calling area of this city. Consult the blue pages in your local telephone directory for additional information. The ministry may also be reached 24 hours a day through the emergency telephone number in Toronto (416) 965-1211.